Yellow Quill’s Drinking Water
Part 3: A Solution Beyond Everybody’s Dreams

By Dr. Hans Peterson

In June 2002, everybody agreed on one thing: the water at Yellow Quill’s water sources needed some heavy artillery. I moved to Yellow Quill and set up two 48-foot trailers. One was for water piloting, with the second one for housing a laboratory and accommodation at the well head some 13 kilometres from the Yellow Quill community.

Has Anybody Encountered Bad Smelling Water?
We moved the trailers in early July 2002 and it was hot during the first several days at Yellow Quill. The first thing I noticed after the water was hooked up to the piloting trailer was that it smelled a little bit like rotten eggs. This water was straight from the well. I proceeded to take a shower the same day the well was hooked up. The shower was in the same trailer as all the treatment units that we were using. Coming out of the shower I had a very strange feeling that I had fixed the smell of the water before I had my first shower.

To Drink or not to Drink the tap water
Have you ever thought about that? Most of the water at August 2015

The 13 problems are all too high in our raw water sources. Most of these compounds except where noted don’t smell and they don’t give the water a taste although some may taste or two of these compounds:

1. Total Dissolved Solids (TDS), or conductivity (conductivity times a number = TDS), high TDS tastes salty
2. Calcium
3. Magnesium
4. Hardness, Calcium + Magnesium
5. Sulphate, a laxative
6. Hydrogen sulphide, rotten egg smell, BF
7. Methane, no smell, BF
8. Iron, anaerobic no colour, aerobic browndish-black, stains clothes, sinks and toilets etc., BF
9. Manganese, anaerobic no colour, aerobic browndish-black, stains clothes, sinks and toilets etc., BF. At levels above 0.5 mg/L manganese is toxic (Canada’s guideline is 0.05 mg/L, aesthetic guideline)
10. Ammonium, interferes with chlorination, BF
11. Retractive dissolved organics, reacts with treatment desem from one another and forms chlorination by-products like trihalomethanes, can form slime
12. Bioavailable dissolved organics, BF, see Point 11

What is Biological Treatment of Water?

In biological treatment biofilm-forming bacteria are used to treat the water. Trillions of such bacteria are required. These bacteria attach themselves with a “plank” to the material that we have in a series of three vessels. Each vessel or filter tank contains totally different “ consortia” of bacteria.

A consortium of bacteria is a large number of different bacteria that work together to purify the water. In the IBROM process we estimate that there is more than 30 different types of bacteria in each filter. Selecting the right organisms to purify the water is a key element of biological treatment. We cannot add any bacteria, so for each water source we need to tease out the right ones. I am a bioengineer/biologist and identifying what bacteria prefer has been a tremendous advantage in the IBROM development.

Early attempts to carry out biological filtration used sand with Indian Affairs supporting some slow-sand filtration applications on First Nations water in Canada. Sand, however, is a very inefficient material to attach bacteria to and most water treatment plants would select better materials. The most common material is Granular Activated Carbon (GAC), but it has a lot of problems associated with it and while we tested it I was hoping to find a better material.

Filtralite shines
Filtralite had done extensive tests with Filtralite a very large European water treatment company declared that it was the best water filtration material in the world and proceeded to replace sand with Filtralite in water treatment plants serving millions of people in Europe including the City of London. I was pretty much convinced as well that it would be very difficult to beat Filtralite and further pilot testing and full-scale testing has borne this out.

The Filtralite material is added into filter tanks and the water flows through it removing providing food for bacteria 24 hours a day. We also make sure that the right Filtralite material is used and that each filter has the best conditions possible for the types of bacteria that we grow in it.

The key attributes of the Filtralite material is that it is inert and has low loss rates. A competing material, GAC literally crumbles with age releasing “fines” or debris breaking off from the GAC. This debris is loaded with bacteria. Another advantage of Filtralite is that it has uniformly-sized “rooms” for bacteria while other materials can have a mixture of rooms that are too small or too large. Think about it. Bacteria can only attach to the floor, walls and ceiling of the rooms. Compare a room that is concert hall-sized as opposed to hundreds of smaller rooms that have far greater area of surfaces for bacteria to attach to. The more bacteria we can grow, the better the biological treatment. That’s why concert hall-sized rooms are simply too large.

In summary what counts is having the largest area (walls, ceilings and floors) where bacteria can attach. The larger the number of bacteria, the better the treatment. But, there is one restriction. Water needs to constantly flow across the bacteria to make them the virtual water filters they are. If your rooms are tiny closets, bacteria may not be able to get in there and attach, but no water will flow by them to treat the water. The photo below is taken by a powerful electron microscope and it shows bacteria attached to the Filtralite material. For optimum treatment the water will flow directly through Filtralite material. (see picture on page 19)

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Trillions of Bifidobacteria on Filterrate Material Can be the Heavy Lifting

There are water treatment plants that remove red egg smell and other smells from the water as well as compounds, such as iron, manganese, ammonium, organic material, arsenic and the list goes on. The bacteria do this by fermenting the carbohydrates in the water. These bacteria are only interested in compounds that can either be a nutrient source or energy source for them so even with the best coaching we will end up with compounds that have not been removed, such as sodium, sulphate, chlorides, amongst others. So for refractive organic material etc. These compounds will flocculate in the RO process where they are removed. It is essential that the RO membrane does not get damaged, it will look like a smoking gun. If you have a clear water treatment plant in operation that has been fouled is white. This is where the federal government has invested millions of dollars to convert the water treatment system were slowly coming ahead of his ROs Bob Pratt cleaned his membranes every week. This frequent cleaning does one more of the membranes – it damages the integrity of the membranes. Even one mash ball can have significant effect. You can determine this is because the structure of the membrane and many undesirable compounds can start to attach to it. How do we tell if your RO membranes are damaged? If you notice that you need to add higher amounts of chlorine after a membrane cleaning you are dealing with damaged membranes. You need to measure TDS of the permeate water (this is what we drink) from the RO. Increases in TDS are again caused by damaged RO membranes. It may take a few cleanings before the damage will become measurable so keep watching your chlorine levels. If the permeate water smells then you need to add those compounds that are typically present in the effluent of some IBROM processes as it removes hydrogen sulphide (rotten egg smell) but then there is no smell. What happened? Bacteria in the treated water reservoir that comes from the IBROM process. Bacteria in the distribution system is something that I experienced with in the past and will deal with 20 years from now. But, meanwhile, some bacteria like Mycobacterium tuberculosis grow on the sides of distribution system and household pipes and a single main problem for both these bacteria and ibrom bacteria is from breathing in aerosols while showers. The RO Dilemma: Scaling and Fouling

Many people around the world have now realized that inorganic compounds in the treated water quality will be high. How to get rid of chlorine, antibiotics and other compounds is a huge task. The developed biological processes are a lot of things that can foul RO membranes. Fouling can be caused by scaling when inorganic compounds like calcium and sulphate go from being dissolved in the water to forming solids. When you buy sugar it is a solid, but when you add it into your tea it becomes dissolved. With inorganic compound fouling, we need to consider the issue of water antiscalants cannot keep everything in solution. But then there is another big problem for the RO to contend with: fouling. Fouling is effectively plugging holes in the membrane. There are a lot of things that can foul RO membranes. Fouling can be caused by organic material sticking to the membrane, for instance, can be caused by food for bacteria in the water. Bacteria can then attach to the concentrate side of the membrane and all they need to do is to grow and reproduce: this will plug the membrane holes. Bacterial food is removed by the IBROM process, while other processes remove or no or small amounts of the food bacteria can do. One reason for putting nano-membranes into a community (water treatment plant) rather than RO membranes was mentioned above as the decrease needed to pH adjustment the treated water even if this comes with a heavy cost as we get to drink garbage liquor. However, lower requirements to pH adjustment is often argued to be an advantage of using nano-filtration membranes in the IBROM process. This is incorrect. A poor reason why nano-membranes are installed is that they don’t scale or foul as easy as RO membranes. So if a city council company cannot produce a pristine water for the membranes to treat it is hoping that it will just plug the membrane for the nano-membranes to scale and foul. The IBROM Treatment taking shape

Thanking the most attractive quality problems in Yellow Quill’s raw water I started to realize that I, as a water treatment scientist, got the best job ever – some of the chemically-poorest water sources on earth to play with. In other places they have a few problems in the raw water, in Saskatchewan we had, and continue to have, around a dozen problems both in ground water and in surface water. This is not about juggling two or three balls, this is about juggling a dozen. The developed biological processes ahead of the RO resulted in no scaling or fouling of the RO membranes at Yellow Quill. Finally, the parts for an effective water treatment system were slowly coming together, optimized biological treatment followed by RO treatment. Now, we got pure water. The compounds that the bacteria did not remove will have been removed by the RO membrane. The RO membranes that I like push water through holes that are 30,000 times smaller than the width of a human hair. If you think about that, you realize that the biggest obstacle in treating poor quality water is the fact that poor quality water needs to be pushed through an RO. Well, that is quality to safe to drink.

Two trail blazers at Indian Affairs

This is where the federal government fails First Nations. They fail because they don’t recognize how much better quality water sources are, especially in Saskatchewan. They then apply water treatment technologies that are developed for treating water that is of much better quality than what First Nations have access to. Many experts in this field thing about that, you realize that the biggest obstacle in treating poor quality water is the fact that poor quality water needs to be pushed through an RO. Well, that is quality to safe to drink.

Indian Affairs

A dog’s breakfast water treatment plant

Take the water treatment plant that I had called a “dog’s breakfast.” An engineering company at that time had spent $1 million designing the “dog’s breakfast.” Shortly thereafter I got a contract to run an IBROM pilot. It worked well. Yet to my utter disbelievethe Board selected to retain the engineering company and spent another $1 million. There is no smell. What happened? Bacteria in the treated water reservoir that comes from the IBROM process. Bacteria in the distribution system is something that I experienced with in the past and will deal with 20 years from now. But, meanwhile, some bacteria like Mycobacterium tuberculosis grow on the sides of distribution system and household pipes and a single main problem for both these bacteria and ibrom bacteria is from breathing in aerosols while showers. The RO Dilemma: Scaling and Fouling

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